

# Impact of a Workplace Stress Reduction Program on Blood Pressure and Emotional Health in Hypertensive Employees

ROLLIN McCRATY, Ph.D., MIKE ATKINSON, and DANA TOMASINO, B.A.

## ABSTRACT

**Objectives:** This study examined the impact of a workplace-based stress management program on blood pressure (BP), emotional health, and workplace-related measures in hypertensive employees of a global information technology company.

**Design:** Thirty-eight (38) employees with hypertension were randomly assigned to a treatment group that received the stress-reduction intervention or a waiting control group that received no intervention during the study period. The treatment group participated in a 16-hour program, which included instruction in positive emotion refocusing and emotional restructuring techniques intended to reduce sympathetic nervous system arousal, stress, and negative affect, increase positive affect, and improve performance. Learning and practice of the techniques was enhanced by heart rate variability feedback, which helped participants learn to self-generate *physiological coherence*, a beneficial physiologic mode associated with increased heart rhythm coherence, physiologic entrainment, parasympathetic activity, and vascular resonance. BP, emotional health, and workplace-related measures were assessed before and 3 months after the program.

**Results:** Three months post-intervention, the treatment group exhibited a mean adjusted reduction of 10.6 mm Hg in systolic BP and of 6.3 mm Hg in diastolic BP. The reduction in systolic BP was significant in relation to the control group. The treatment group also demonstrated improvements in emotional health, including significant reductions in stress symptoms, depression, and global psychological distress and significant increases in peacefulness and positive outlook. Reduced systolic BP was correlated with reduced stress symptoms. Furthermore, the trained employees demonstrated significant increases in the work-related scales of workplace satisfaction and value of contribution.

**Conclusions:** Results suggest that a brief workplace stress management intervention can produce clinically significant reductions in BP and improve emotional health among hypertensive employees. Implications are that such interventions may produce a healthier and more productive workforce, enhancing performance and reducing losses to the organization resulting from cognitive decline, illness, and premature mortality.

## INTRODUCTION

Hypertension is considered one of the most prominent public health issues faced by

the world today. In the United States alone, it affects approximately 50 million people, or 1 in 4 adults (National Heart, Lung, and Blood Institute, 1997), and current trends suggest that

the number of adults diagnosed with high blood pressure (BP) is increasing (Ayala et al., 2002). High BP is a major risk factor for death and disability related to coronary heart disease, heart attacks, strokes, kidney disease, and vascular complications (National Heart, Lung, and Blood Institute, 1997). In addition, high systolic BP has been linked with decreased cognitive performance, memory loss, and the loss of healthy brain tissue (Launer et al., 1995; Swan et al., 1998). Conversely, reducing BP in hypertensive individuals has been found to reduce the risk of death and disability significantly, and is therefore a critically important factor in employee health (Hypertension Detection and Follow-up Program Cooperative Group, 1979; Launer et al., 1995; MacMahon et al., 1990; Thijs et al., 1992).

There is considerable evidence to suggest that high BP is linked to persistent stress and the way in which people cope (Henry et al., 1986; Linden, 1984; Markovitz et al., 1993; Shapiro, 1996; Step-toe, 1986). Chronic psychological stress is associated with increased activation of the sympathetic-adrenomedullary axis and increased circulating levels of adrenaline and noradrenaline. Chronically elevated adrenaline levels have been implicated in the development and progression of hypertension (Julius et al., 1988; Ruman-tir et al., 2000; Schalekamp et al., 1983), and hypertensive subjects have been demonstrated to have increased sympathetic and reduced parasympathetic tone compared to healthy controls (Guzzetti et al., 1988; Langewitz et al., 1994). Conversely, behavioral interventions that reduce stress and sympathetic arousal have been shown to be effective nonpharmacologic treatments for hypertension; such treatments have been associated with clinically significant and sustainable BP reductions as well as lowered health care costs (Charlesworth et al., 1984; Chesney et al., 1987; Linden and Chambers, 1994; Mathias, 1991; Ward et al., 1987; Weiss, 1988).

In addition to being implicated in the development and aggravation of hypertension and other health problems, employee stress and emotional well-being have also been identified as important determinants of organizational health, performance, and productivity. For example, high levels of emotional

distress have been found to be among the most costly health problems to employers in terms of absenteeism, disability, and failure to meet productivity standards (Burton et al., 1999). Depression, a common problem among workers, costs the United States \$44 billion per year in lost productivity, according to a National Foundation for Brain Research survey of human resource professionals conducted in 1999. Another nationwide survey conducted by the New York Business Group on Health revealed that each employee suffering from stress, anxiety, or depression is estimated to lose 16 days of work per year compared to an average of 4–6 lost workdays for all employees. Additionally, in a recent 3-year analysis of more than 46,000 workers from six major companies, depression and unmanaged stress emerged as the top two most costly risk factors in terms of medical expenditures—increasing health care costs by 2–7 times as much as physical risk factors such as smoking, obesity, and poor exercise habits. In this study, combined psychosocial problems, including stress and depression, led to costs nearly 2.5 times higher than those of workers who did not report these concerns (Goetzel et al., 1998).

In contrast, studies conducted across a broad range of settings have linked positive emotion and psychological well-being to numerous organizationally relevant benefits, including reduced absenteeism (Iverson et al., 1998), increased cognitive flexibility and innovative problem solving (Ashby et al., 1999; Isen, 1998), and improved negotiation style (Carnevale and Isen, 1986), creativity (Isen, 1998; Isen et al., 1987), decision-making (Isen, 2000), job performance (Staw and Barsade, 1993; Wright and Staw, 1999), job achievement (Staw et al., 1994), and job satisfaction (Woodward and Chen, 1994). The growing body of research demonstrating the favorable impact of positive emotions on performance and health (Blakeslee, 1997; Danner et al., 2001; Salovey et al., 2000) has recently fueled an interest in developing and implementing interventions that cultivate positive emotions in the workplace (Childre and Cryer, 2000; Cooper-rider and Whitney, 2000; Fredrickson, 2000b)

and in daily life (Fredrickson, 2000a; McCraty and Childre, 2003; Seligman and Csikszentmihalyi, 2000).

The purpose of this study was to determine if a positive emotion-focused stress management program known as Inner Quality Management® (IQM; Institute of HeartMath, Boulder Creek, CA) could reduce BP and improve emotional health in known hypertensive employees. The IQM program teaches individuals a number of practical self-management techniques designed to reduce stress and negative affect, increase positive affect, enhance health, and improve business performance (Childre and Cryer, 2000). Previous studies have demonstrated that the IQM techniques favorably impact physiologic balance by reducing sympathetic arousal, increasing parasympathetic activity (McCraty et al., 1995; Tiller et al., 1996), reducing cortisol levels, increasing dehydroepiandrosterone (DHEA) (McCraty et al., 1998), and enhancing immune system activity (McCraty et al., 1996; Rein et al., 1995). These techniques have also been shown to impact organizationally relevant outcomes, such as improving cognitive performance (McCraty, 2002b; McCraty and Atkinson, 2004), productivity, communication, and job satisfaction and reducing employee turnover (Barrios-Choplin et al., 1997, 1999; Childre and Cryer, 2000).

In addition, practice of the IQM techniques has been demonstrated to improve health status in a number of clinical populations (McCraty et al., 2004), including individuals with congestive heart failure (Luskin et al., 2002), diabetes (McCraty et al., 2000), and acquired immune deficiency syndrome (AIDS) (Rozman et al., 1996). In particular, a number of pilot studies conducted at Motorola, Shell, and British Petroleum have demonstrated that executives with stage 1 and stage 2 hypertension who participated in an IQM training program were able to restore their BP to normal values without the aid of medication after practicing the IQM techniques (Barrios-Choplin et al., 1997; McCraty et al., 2001; A.D. Watkins\*). However, these pilot studies were uncontrolled for BP outcomes, and the subject populations included only a small number of hypertensive employees.

In the present study, the impact of the IQM program was investigated specifically in a group of hypertensive individuals, using a randomized controlled trial design. Psychological and work performance-related parameters were assessed concurrently with BP changes to determine the overall impact of the program on employees' emotional health and workplace effectiveness.

## METHOD

### *Eligibility, recruitment, and attrition*

The target population consisted of male and female hypertensive employees of a global information technology company. Initial BP eligibility criteria required that each participant had been diagnosed with hypertension by his/her primary care physician. Participants either must have been taking antihypertensive medication on a regular schedule, or must have had at least 1 of the 4 baseline BP readings (average of 3 successive measurements) in the range of 90–105 mm Hg diastolic or 140–179 mm Hg systolic.

Over a 4-week period, 50 individuals recruited from a site-wide e-mail announcement were screened for eligibility for the program. Of these, 38 were included in the study and randomly assigned to either a treatment group, which received the IQM training, or a waiting control group, which received no intervention during the study period but received the IQM training once the study was completed. The most common reason for exclusion of candidates during the baseline period was for schedule conflicts or, less commonly, personal reasons. Of the 38 participants, 6 were excluded from the analysis during the 3-month study period. The reasons for exclusion were because of changes in antihypertensive medications prescribed by the participant's physician (2 treatment group and 2 control group participants) or because the participant began a vigorous exercise program shortly after the baseline measurement period

---

\*Unpublished work from 1998 and 1999.

ended (1 treatment and 1 control group subject). Therefore, 32 participants completed the study (18 in the treatment group and 14 in the waiting control group).

#### *Baseline assessment and randomization*

Subjects' baseline BP was measured once per week for 4 consecutive weeks. All BP measurements were obtained using a stationary automated BP monitor with digital readout (model UA-743, A&D Medical, Milpitas, CA) that was calibrated against a mercury sphygmomanometer at regular intervals. BP readings were taken by nurses hired from a local temporary employment agency, who were blinded to the experimental conditions.

Readings were taken with subjects in the seated position after they had been at rest for 5 minutes while not practicing any stylized relaxation technique. Three BP readings, taken at 2-minute intervals, were recorded at each visit. All three readings were averaged to give the final reading for that visit. Psychometric data were also collected at one of the first two baseline measurement sessions. Psychological surveys used were the Personal and Organizational Quality Assessment (POQA) (Barrios-Choplin and Atkinson, 2000), which provides a broad-based assessment of emotional health, psychosocial functioning, and work performance-related outcomes, and the Brief Symptom Inventory (BSI) (Derogatis, 1993), a clinically valid measure of key indices of psychological distress.

Final baseline BP level was based on three measurements recorded at each of the last two baseline measurement sessions. After completion of the last baseline measurement the subjects were randomly assigned to either the treatment group or waiting control group. Two participants were unable to meet the schedule of the group to which they were assigned because of work-related travel or other work-related responsibilities, and therefore crossed over to the other group. Because the study utilized a wait list control design and both these participants knew they would receive the intervention, there was no bias or disappointment generated by one participant feeling that he would miss receiving the benefits of the program. In addition, one participant crossed

over in each direction; thus, the crossover was not considered detrimental to the internal validity of the study, and both participants' data were therefore included in the analysis.

#### *Intervention*

The IQM training was delivered in 1 full-day (8-hour) and 2 half-day (4-hour) sessions over the course of 2 weeks. In the program, participants learned positive emotion refocusing and emotional restructuring techniques intended to help arrest or prevent psychological and physiologic stress responses, increase mental acuity and emotional stability, improve autonomic balance, and reinforce healthy patterns of mental, emotional, and physiologic activity (Childre and Cryer, 2000; Childre and Martin, 1999). The training emphasized practical applications of these techniques in the organizational setting to improve outcomes such as communication effectiveness, goal clarity, creativity, productivity, and team coherence.

Among the core tools learned in the program were the Freeze-Frame<sup>®</sup> (Institute of Heart Math) and Heart Lock-In<sup>®</sup> (Institute of Heart-Math) techniques. Freeze-Frame (Childre, 1998) is a 1-minute positive emotion refocusing technique used to shift perception and transform inefficient mental and emotional responses to stress in real time. This technique consists of five simple steps in which the individual identifies a stressful or disturbing feeling, puts a temporary pause on it—similar to freezing the frame of a movie or video, shifts his or her focus to the area of the heart, breathes as if the breath were coming in through the heart area and out through the solar plexus, and self-generates a genuine positive feeling, such as appreciation or care. The combination of focus in the heart area and genuinely experiencing a positive emotion leads to increased synchronization and harmony in nervous system dynamics, thus interrupting or preventing the body's normal stress response. This shift has a salutary effect on physiologic functioning and also facilitates higher cognitive faculties and emotion regulation abilities that are normally compromised during stress, thus enabling the individual to address the original stressor from a more balanced and objective vantage point.

Heart Lock-In (Childre and Martin, 1999; Childre and Rozman, 2002) is an emotional restructuring technique that enables people to build the capacity to sustain positive affective states, and their psychological and physiologic benefits, for longer periods. Using this technique, individuals learn to self-generate and maintain a distinct mode of physiologic functioning known as *physiological coherence*, which has been shown to be associated with the sustained experience of positive emotions (McCraty and Childre, 2002). The physiologic coherence mode is associated with increased efficiency, synchronization, and harmony in the functioning of physiologic systems. This mode is characterized by a smooth, sine wave-like heart rate variability pattern (heart rhythm coherence), which reflects increased synchronization in the reciprocal action of the two branches of the autonomic nervous system; reduced sympathetic activation and increased parasympathetic activity; as well as increases in vascular resonance, heart-brain synchronization, and entrainment between diverse physiologic oscillatory systems (McCraty and Atkinson, 2004; McCraty and Childre, 2003, Tiller et al., 1996). The Heart Lock-In technique reinforces these beneficial physiologic patterns, which with practice, grow increasingly familiar to the system. In addition, the practice of tools and techniques that increase physiological coherence has been associated with improved cognitive performance in discrimination and reaction time tasks (McCraty, 2002b; McCraty and Atkinson, 2004), and has been linked to a range of favorable psychosocial outcomes, including increased caring and contentment, and reduced anxiety, depression, hostility, and burnout (Barrios-Choplin et al., 1997; Luskin et al., 2002; McCraty et al., 1998). Importantly, the physiological coherence mode is both physiologically and psychologically distinct from the relaxation response, and promotes a calm, balanced, yet alert and responsive state that is conducive to tasks requiring focus, discrimination, and mental acuity (McCraty and Atkinson, 2004; McCraty and Childre, 2002).

The training program also incorporated a heart rhythm education and feedback component to facilitate learning and effective implementation of

the stress management techniques (McCraty, 2002a). Using a computerized heart rhythm monitoring and feedback system (Freeze-Framer®; Quantum Intech, Inc., Boulder Creek, CA), participants' heart rate variability patterns (heart rhythms) were displayed in real time as they practiced the Freeze-Frame and Heart Lock-In techniques. This enabled participants to see and feel for themselves how stress and different emotions affect their autonomic nervous system, and to objectively view and quantify the favorable shifts in autonomic function they could achieve by using the techniques. This process also facilitated the experience of the internal emotional shift necessary to increase physiological coherence (as reflected in a more sine wave-like heart rate variability pattern, a numerical "coherence ratio" score, or degree of success in playing one of several on-screen games designed to reinforce the coherence-building skills).

During the 3 months after the final training session, participants were encouraged to practice the tools daily. As previously stated, the Freeze-Frame technique is intended to be used when one experiences a stressful feeling, and this technique therefore has numerous applications in workplace settings. The most commonly reported use is in meetings. It can also be helpful to use the technique before making phone calls or during challenging conversations, such as with upset customers or coworkers. Another frequently reported use is in managing the reactions people feel when they are interrupted or need to shift focus. The Heart Lock-In technique is often used before going into a meeting, to increase focus and clarity prior to making important decisions, to promote innovative thinking, to relieve anxiety or fatigue, and when making the transition from work to home.

Six heart rhythm feedback units were made available to treatment group participants for use in the workplace and for personal use during weekends. One optional 2-hour follow-up session was held 8 weeks after the training to review the techniques and answer participants' questions and concerns regarding their practice. Additionally, participants received regular e-mail messages that provide tips for applying the IQM techniques in business settings.

Finally, treatment group participants were encouraged to arrange informal meetings among themselves in order to support one another in their continued practice of the tools.

#### *Post-intervention assessment*

Post-intervention BP measurements were obtained 3 months after the completion of the training program, in a series of two sessions spaced 1 week apart. Final BP level was based on the three measurements recorded at each of these two postintervention measurement sessions following the same protocol outlined above. Psychometric data were also collected at the first of these two measurement sessions.

#### *Data analysis*

The BP outcomes of the intervention were assessed statistically by analysis of covariance (ANCOVA) with BP change as the outcome variable. To adjust for any effects of baseline BP, age, gender, body mass index, and medication status, these variables were used as covariates in the analysis. Change in BP was defined as 3-month post-training BP minus baseline BP. Significance was set at a value of  $p < 0.05$ . Psychological survey outcomes were also assessed by ANCOVA, with post-intervention score for each scale as the outcome variable and its baseline score as the covariate. In addition, change scores for pre-post psychological and BP outcomes were subject to a correlation analysis.

## RESULTS

#### *Baseline characteristics*

Table 1 presents baseline demographic and BP characteristics of participants across both groups. The mean age was 46 years (age range, 35–59). The study sample consisted of 9 females (28%) and 23 males (72%). Mean height and weight were 5 feet 9 inches, 200 pounds, and mean body mass index was 29. Mean baseline BP was 129/83 mm Hg. Seventy-eight percent (78%) of the participants were taking antihypertensive medications. Among the baseline characteristics assessed by single-factor analysis of variance (ANOVA), only age differed

significantly between the groups (treatment group,  $48.2 \pm 6.5$  years; control group,  $43.1 \pm 5.6$  years;  $p < 0.05$ ).

#### *BP outcomes*

Both groups showed reductions in systolic and diastolic BP over the study period. The reduction in systolic BP in the treatment group was significantly larger than that in the control group ( $p < 0.05$ ). The treatment group demonstrated a mean adjusted reduction of 10.6 mm Hg in systolic BP, compared to a mean adjusted reduction of 3.7 mm Hg in the control group. For diastolic BP, the treatment group showed a mean adjusted reduction of 6.3 mm Hg, while the control group demonstrated a mean adjusted reduction of 3.9 mm Hg. Table 2 and Figure 1 display the systolic and diastolic BP changes in both groups adjusted for baseline BP, age, gender, body mass index, and medication status.

Because of the reductions in BP they were able to achieve using the techniques, three participants in the treatment group who were regularly taking antihypertensive medications were able to reduce their medication usage, with their physicians' approval, during the study period. Of these, one participant was permitted to discontinue medication usage entirely following completion of the study.

#### *Psychological and performance outcomes*

**POQA results.** The results of the POQA survey revealed significant improvements in key indicators of both individual well-being and organizational effectiveness in the treatment group 3 months after the IQM program, compared to the control group. Specifically, on measures of individual well-being, the treatment group demonstrated significant increases in Positive Outlook ( $p < 0.01$ ) and Peacefulness ( $p < 0.05$ ) and a significant reduction in Stress Symptoms ( $p < 0.05$ ). Furthermore, the trained employees demonstrated significant increases in the work-related scales of Workplace Satisfaction ( $p < 0.05$ ) and Value of Contribution ( $p < 0.001$ ). None of the other scales showed significant differences. Table 3 provides a summary of the POQA results.

TABLE 1. BASELINE CHARACTERISTICS OF TREATMENT AND CONTROL GROUPS

	Treatment group		Control group		p
	Mean	SD	Mean	SD	
Age (years)	48.2 ± 6.5		43.1 ± 5.6		<0.05
Gender, % male	72%		71%		ns
Height (ft)	5.8 ± 0.3		5.7 ± 0.4		ns
Weight (pounds)	202.7 ± 46.7		196.9 ± 38.1		ns
Body mass index	29.4 ± 6.6		28.9 ± 4.8		ns
Systolic BP	130.4 ± 11.1		128.1 ± 8.0		ns
Diastolic BP	82.9 ± 10.2		84.1 ± 7.6		ns
Heart rate	70.5 ± 12.6		72.5 ± 10.3		ns
Antihypertensive medication status, % taking medications	78%		79%		ns

BP, blood pressure; SD, standard deviation; ns, not significant.

*BSI results.* The BSI survey revealed a significant reduction in symptoms of depression and phobic anxiety among the treatment group participants compared to the control group ( $p < 0.05$ ). The IQM group also showed a significant reduction in the Global Severity Index score (a reflection of the overall severity of psychological distress) relative to the control group ( $p < 0.05$ ). None of the other scales showed significant differences. Pre- and post-intervention BSI scores for both groups are shown in Table 4.

*Correlation analysis.* Correlation analysis of the pre-post change scores (post – pre) for survey results and BP outcomes revealed a number of significant relationships. The reduction in Stress Symptoms was correlated with the reduction in systolic BP ( $R = 0.44, p < 0.05$ ). Reduced Depression was correlated with increased Value of Contribution ( $R = -0.43, p < 0.05$ ) and Job Challenge ( $R = -0.39, p < 0.05$ ), and with reduced Fatigue ( $R = 0.47, p < 0.01$ )

and Intention to Quit ( $R = 0.47, p < 0.01$ ). Increased Positive Outlook was correlated with reductions in Anger ( $R = -0.49, p < 0.01$ ) and Depression ( $R = -0.43, p < 0.05$ ), and with increased Value of Contribution ( $R = 0.57, p < 0.01$ ) and Workplace Satisfaction ( $R = 0.63, p < 0.01$ ). Increased Value of Contribution was also correlated with improved Supervisor Relations ( $R = 0.57, p < 0.01$ ), increased Workplace Satisfaction ( $R = 0.63, p < 0.01$ ), and decreased Intention to Quit ( $R = -0.43, p < 0.01$ ). Increased Workplace Satisfaction was also correlated with increased Job Challenge ( $R = 0.77, p < 0.01$ ), improved Supervisor Relations ( $R = 0.63, p < 0.05$ ), and decreased Intention to Quit ( $R = -0.64, p < 0.01$ ).

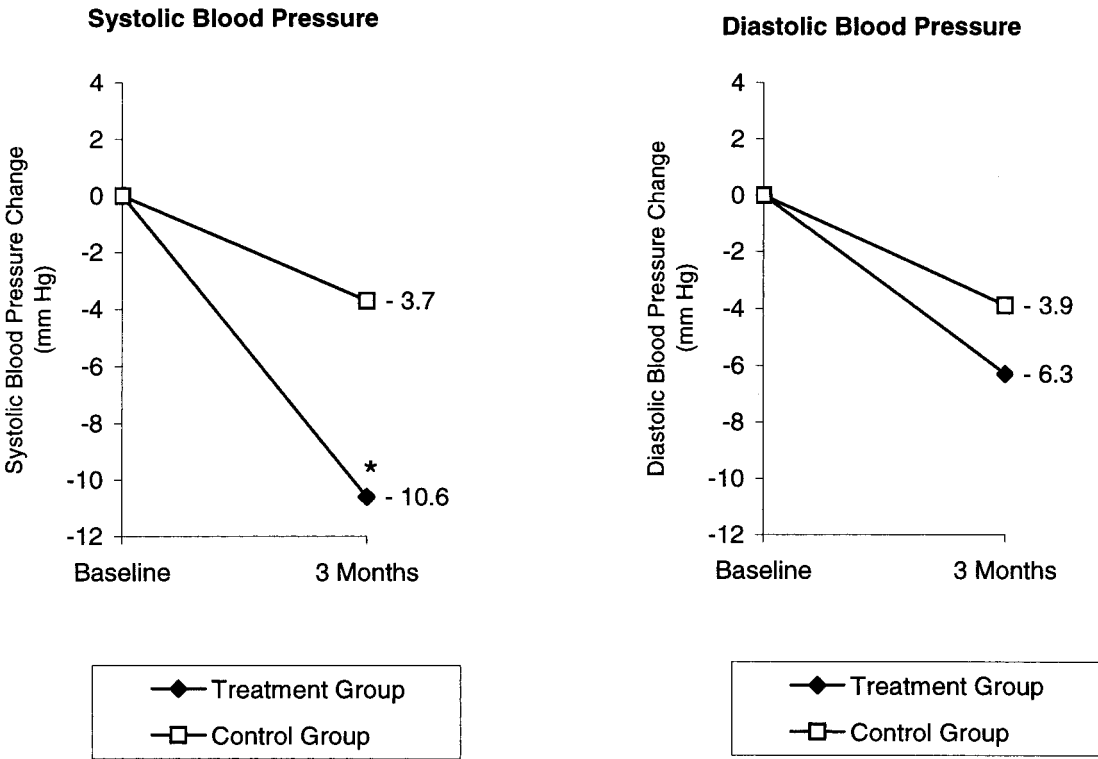
A correlation analysis between the BSI and POQA survey scales was also performed and revealed significant correlations between the Anxiety scales ( $R = 0.738, p < 0.001$ ) and Depression scales ( $R = 0.695, p < 0.001$ ) on both instruments, and between the POQA Stress

TABLE 2. BLOOD PRESSURE CHANGES FROM BASELINE FOR TREATMENT AND CONTROL GROUPS

	Treatment group		Control group		p
	Mean	SEM	Mean	SEM	
Systolic BP					
Change, mm Hg	-9.0 ± 3.0		-5.7 ± 3.1		<0.05
Adjusted change, mm Hg <sup>a</sup>	-10.6 ± 2.1		-3.7 ± 2.4		
Diastolic BP					
Change, mm Hg	-5.5 ± 2.3		-4.9 ± 2.3		ns
Adjusted change, mm Hg <sup>a</sup>	-6.3 ± 1.2		-3.9 ± 1.4		

SEM, standard error of the mean; BP, blood pressure; ns, not significant.

<sup>a</sup>Covarying for baseline BP, age, gender, body mass index, and medication status.



**FIG. 1.** Pre-post blood pressure (BP) changes for treatment and control groups. Line graphs show mean changes in systolic and diastolic BP, adjusted for baseline BP, age, gender, body mass index, and medication status, as measured 3 months post-Inner Quality Management® (Institute of HeartMath, Boulder Creek, CA) training. \**p* < 0.05.

Symptoms scale and the Somatization scale of the BSI (*R* = 0.788, *p* < 0.001).

**DISCUSSION**

This study demonstrated the feasibility and short-term efficacy of a workplace-based stress reduction program (the IQM program) in the treatment of employees with hypertension. After 3 months of follow-up, the IQM group significantly reduced systolic BP compared to a control group. The treatment group also exhibited a reduction in diastolic BP; however, this reduction did not achieve statistical significance because of a parallel but smaller reduction in diastolic BP in the control group. Concurrent reductions in measures of emotional distress and improvements in psychological well-being were also observed in the treatment group. Finally, the favorable changes in BP and psychological measures were accompanied by organizationally relevant improvements in workplace satisfaction and perceived

value of work contribution, suggesting that the intervention was effective in facilitating attitude changes that not only affect the individual, but may also influence the dynamics of the workplace environment.

There were a number of scales that did not significantly improve. It is unclear as to why some of these scales, such as anger, fatigue, and anxiety, did not show significant improvements, given that these scales have significantly improved in previous workplace studies that assessed the psychological impact of the IQM intervention (Barrios-Choplin et al., 1997, 1999; Childre and Cryer, 2000). The lack of significant change in the current study may be because of the fact that the control group also demonstrated improvements in these scales, although the intervention group's changes were larger than those of the control group. The improvements in control group participants may have been caused by other workplace factors and/or driven by the increased attention, contact, and awareness of their physical and emotional health afforded by their participation in the study.



TABLE 3. PERSONAL AND ORGANIZATIONAL QUALITY ASSESSMENT PRE-POST SCORES FOR TREATMENT AND CONTROL GROUPS

	Treatment group				Control group				Effect size	p
	Pre		Post		Pre		Post			
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Stress symptoms	2.42	0.81	1.95	0.60	2.77	0.68	2.55	0.68	−0.36	<0.05
Anger	2.04	0.84	1.61	0.49	2.14	0.63	2.00	0.79	−0.42	ns
Resentfulness	2.28	0.71	2.14	0.58	2.55	0.66	2.47	0.90	−0.07	ns
Anxiety	2.53	1.06	2.06	0.81	2.76	0.74	2.59	1.08	−0.32	ns
Depression	1.84	0.64	1.54	0.52	2.21	0.61	2.19	1.03	−0.37	ns
Fatigue	2.67	1.15	2.28	0.89	3.15	1.01	3.00	0.86	−0.23	ns
Positive outlook	4.16	1.02	4.78	0.80	4.39	1.17	4.40	1.03	0.60	<0.01
Easygoingness	4.41	1.03	4.75	0.81	4.99	0.67	5.00	0.65	0.40	ns
Peacefulness	3.22	1.09	3.96	0.94	3.10	0.96	3.13	0.81	0.74	<0.05
Spouse or partner support	4.68	0.97	4.94	0.79	4.68	1.17	4.42	1.63	0.44	ns
Workplace satisfaction	4.41	1.06	4.58	0.91	4.50	0.94	4.05	0.97	0.64	<0.05
Value of contribution	4.21	0.87	4.94	0.54	4.64	0.89	4.25	0.98	1.35	<0.001
Time pressure	3.78	0.99	3.79	0.96	3.67	1.44	3.40	0.99	0.24	ns
Supervisor relations	4.51	0.99	4.62	1.09	4.35	0.96	3.97	1.38	0.44	ns
Communication effectiveness	3.87	0.96	4.13	0.88	3.77	1.16	3.57	1.28	0.43	ns
Freedom of expression	4.38	1.11	4.41	0.90	4.29	1.27	4.43	1.09	−0.11	ns
Goal clarity	4.18	1.04	4.41	1.02	3.54	1.10	3.71	1.20	0.05	ns
Job challenge	4.12	1.25	4.34	1.18	3.71	1.32	3.36	1.42	0.45	ns
Intention to quit	2.29	1.28	2.38	1.26	3.00	1.43	3.39	1.79	−0.21	ns

SD, standard deviation; ns, not significant.

The results of this study confirm data from previous case studies suggesting that the IQM techniques are effective in reducing BP in hypertensive individuals within a relatively short period of time (Barrios-Choplin et al., 1997; McCraty et al., 2001; A.D. Watkins\*). The BP reductions achieved in this study compare favorably with those associated with other treatment

approaches, both pharmacologic and nonpharmacologic. For example, the reduction in BP of approximately 11/6 mm Hg obtained with the IQM program in this relatively short-term study is similar in magnitude to the average reduction in BP reported in a meta-analysis of controlled trials of antihypertensive drug therapy of several years' duration (Collins et al.,

TABLE 4. BRIEF SYMPTOM INVENTORY PRE-POST SCORES FOR TREATMENT AND CONTROL GROUPS

	Treatment group				Control group				Effect size	p
	Pre		Post		Pre		Post			
	Mean	SD	Mean	SD	Mean	SD	Mean	SD		
Somatization	0.53	0.46	0.35	0.42	0.62	0.46	0.55	0.54	−0.22	ns
Obsessive–compulsive	0.92	0.72	0.64	0.39	0.97	0.67	0.93	0.69	−0.39	ns
Interpersonal sensitivity	0.68	0.62	0.29	0.33	0.79	0.71	0.59	0.62	−0.32	ns
Depression	0.51	0.59	0.23	0.27	0.51	0.40	0.61	0.68	−0.74	<0.05
Anxiety	0.52	0.43	0.30	0.30	0.88	0.46	0.57	0.35	0.24	ns
Hostility	0.46	0.44	0.24	0.26	0.40	0.26	0.36	0.36	−0.52	ns
Phobic anxiety	0.13	0.19	0.02	0.07	0.23	0.33	0.16	0.21	−0.17	<0.05
Paranoid ideation	0.43	0.55	0.25	0.38	0.74	0.53	0.80	0.86	−0.40	ns
Psychoticism	0.26	0.32	0.14	0.28	0.39	0.36	0.29	0.29	−0.05	ns
Global severity index	0.51	0.35	0.29	0.23	0.61	0.34	0.53	0.36	−0.44	<0.05
Positive symptom distress index	1.34	0.34	1.19	0.16	1.34	0.25	1.31	0.31	−0.43	ns
Positive symptom total	18.11	10.21	12.35	8.77	22.93	10.22	20.00	11.46	−0.28	ns

SD, standard deviation; ns, not significant.

1990). This is approximately twice the average BP reduction associated with interventions that target physical risk factors, such as weight loss (20 pounds) (MacMahon et al., 1987), maintaining a low-salt diet (Cutler et al., 1991), or exercise training (World Hypertension League, 1991).

Evidence suggests that the BP reductions of the magnitude measured in the present study are also clinically meaningful, and, if sustained, should be expected to significantly reduce morbidity and mortality from stroke, cardiovascular, and coronary diseases in the long term. For example, a meta-analysis of randomized trials of antihypertensive treatment, with BP reductions similar to the present trial, found that cardiovascular mortality decreased 22%, stroke mortality 33%, and coronary mortality 26% (Thijs et al., 1992). Furthermore, research indicates that reducing systolic BP by 10 mm Hg in midlife lowers the risk of later impairment of cognitive function by 7%–9% (Launer et al., 1995).

The magnitude of BP reduction achieved in this study is particularly notable given the relatively low pre-treatment BP levels (129/83 mm Hg) in this subject population, which are attributable to the high percentage of subjects taking antihypertensive medications (nearly 80% of subjects). A meta-analysis of 75 controlled clinical trials of relaxation-based stress management treatments for hypertension showed that initial BP level is strongly predictive of subsequent change, with treatments that started with high initial BP levels producing greater reductions (Jacob et al., 1991). Similarly, another review of the literature on stress management approaches has been suggested that low pre-treatment pressure may tend to obscure differences between treatment and control conditions (McCaffrey and Blanchard, 1985). Thus, the magnitude of the blood pressure reductions observed in the present study suggests that the IQM program was a potent intervention, capable of producing clinically meaningful BP reductions in a subject population with relatively low initial BP values, changes that were evident over and above the effects of antihypertensive medication. It is therefore likely that an even greater BP reduction could be expected if this program were delivered to a population with higher starting BP values.

This study also demonstrated significant reductions in psychological distress in employees and improvements in emotional well-being. Of particular relevance to the organization is the significant reduction in symptoms of depression. Depression has been associated with substantially greater overall productivity losses to the organization than most physical diseases (Burton et al., 1999). Studies have also linked depression to serious long-term health risks, including increased risk of heart attacks, death from cardiovascular disease and stroke, as well as all-cause mortality. Importantly, these associations have been shown for self-reported depressive symptoms, similar to those assessed in the present investigation, and not merely clinical levels of depression (Barefoot and Schroll, 1996; Everson et al., 1998; Frasure-Smith et al., 1995). Conversely, studies have shown that reducing depression results in a significant reduction in work disability and improvement in work performance (Berndt et al., 1998). In the present investigation, reduced depression was found to correlate with a number of favorable workplace-relevant changes, including increased perceived job challenge and value of work contribution, and decreased fatigue and intention to leave the organization.

Also worthy of mention is the significant increase in positive outlook experienced by the treatment group in this study. Psychological and organizational research has recently highlighted not only the reduction of negative affect but also the cultivation of positive feelings and attitudes as an important means to enhance human potential and boost organizational performance (Baron, 1993; Fredrickson, 2000a; Fredrickson, 2000b; Staw et al., 1994). Even modest increases in positive affect have been found to produce improvements in a number of organizationally relevant outcomes, including cognitive flexibility, innovation and creative problem-solving, motivation, decision making, memory, prosocial behavior, and bargaining and negotiation processes (for a review, see Isen, 1999). Positive affect has also been predicted to be a precursor to organizational spontaneity (George and Brief, 1992) and has been linked with increased employee productivity (Wright and Staw, 1999); increased helpfulness toward customers (George, 1991, 1998) and co-

workers (George and Brief, 1992); improved job performance (Staw and Barsade, 1993; Wright and Staw, 1999), job satisfaction (Woodward and Chen, 1994), job achievement (Staw et al., 1994); and reduced absenteeism (Iverson et al., 1998) and organizational conflict (Baron, 1993). Furthermore, recent research suggests that positive attitudes among employees are important drivers of profitability (Maister, 2001). In the present study, correlations were noted between increases in employee positive outlook and increased value of contribution and workplace satisfaction.

As a positive emotion-focused intervention, the IQM program teaches employees practical tools and techniques that enable them to reduce stress while systematically increasing their experience of positive feelings and attitudes such as appreciation and care in their day-to-day work and personal lives, thereby improving both well-being and performance. The virtual lack of change in the positive outlook scale among control group employees in this study suggests that spontaneous improvements in employee positive attitudes may be rare, and underscores the need for practical interventions that focus on increasing the prevalence of positive emotions and attitudes in the workplace environment.

The concurrent decreases in BP, reductions in measures of emotional distress, and improvements in psychological well-being observed in the treatment group in this study point to the possibility that by learning to manage stress more effectively and decrease negative emotional arousal, employees were able to self-generate measurable and significant changes in their physiology and health status. In particular, the correlation shown between the significant reductions in systolic BP and stress symptoms provides support for this hypothesis. Although no further correlations between changes in psychological and BP measures were identified in this study, future larger and longer-term studies could be designed to further and more thoroughly investigate the potential relationships between BP reductions and specific psychosocial changes.

This study adds to the growing body of data suggesting that nonpharmacologic interventions that focus on reducing stress and nega-

tive emotional arousal can be effective in reducing high BP and improving well-being in hypertensive individuals (Chesney et al., 1987; Johnston, 1991; Linden and Chambers, 1994; Linden et al., 2001; Schneider et al., 1995; Weiss, 1988). Although similar in some respects to other stress management strategies that have been used in the treatment of hypertension, the intervention employed in this study can also be distinguished from other previously tested interventions in several key ways. First, in contrast to techniques that aim to promote relaxation or alter cognitive processes, the IQM techniques focus primarily on instilling an emotional shift through the activation of positive feeling states. Second, as a result of their positive emotional focus, the IQM techniques are also distinct in their capacity to readily induce the physiological coherence mode, which encompasses beneficial aspects of the relaxation response (e.g., reduced sympathetic activation and increased parasympathetic activity), but also provides additional physiologic and psychological benefits not typically associated with relaxation (e.g., increased synchronization in autonomic nervous system activity, increased vascular resonance and physiologic entrainment, and improved mental clarity and cognitive performance) (McCraty and Atkinson, 2004; McCraty and Childre, 2002; McCraty and Childre, 2003). Third, the IQM program is unique in combining training in positive emotion-focused techniques with heart rate variability feedback, a relatively new type of biofeedback that has been shown to be effective in numerous clinical populations (Lehrer et al., 2000; McCraty, 2002a; Vaschillo et al., 2002). This aspect of the program offers individuals immediate positive feedback and validation of the techniques' effectiveness at the physiologic level, thus increasing motivation to practice. Furthermore, the heart rhythm feedback system utilized in this portion of the intervention is particularly adapted for use in the workplace environment because it uses a simple fingertip pulse sensor as a monitoring device and is intended as a self-educational system that can be used effectively without the aid of a health care practitioner. Finally, unlike a number of other stress management treatments for hypertension that have been reported in the

literature, the IQM program is specifically designed as a workplace-based intervention. As such, a significant portion of the program emphasizes applications of the tools and techniques learned in day-to-day work situations to improve workplace-related dynamics, performance, and business processes.

For practical application in the workplace, the IQM program is intentionally designed as a relatively short program (totaling 16 hours of training over the course of 2 weeks), delivered in a group format. Interestingly, despite the relatively brief time spent in formal training sessions, reports from the company suggest that the trained employees were highly motivated to continue to practice the techniques on their own, as evidenced in the large number of participants who signed up to use the heart rhythm feedback units throughout the study period (post-training heart rhythm feedback practice was optional and therefore not required of participants). Although there are data suggesting that individualized stress management approaches are generally more effective than most standardized approaches in the treatment of hypertension (Linden and Chambers, 1994), in some cases, time and cost constraints may limit the feasibility of the delivery of individualized psychological therapy to members of an employee population. This study suggests that shorter, group-formatted interventions that are adaptable to workplace delivery can also be effective in reducing high BP in a relatively brief period of time and with minimal structured intervention.

The limitations of this study include its relatively small sample size and lack of a placebo control. It is also possible that the favorable outcomes measured may have been influenced by factors other than the intervention alone. For example, the program may have motivated the treatment group to adhere more strictly to their antihypertensive medications, or increased social support from peers who were also participating in the program could have played a role in the observed BP reductions. There is also an inherent limitation in the use of self-report as a measure of psychological outcomes. Nevertheless, the magnitude of the changes generated warrant further investigation.

If a larger controlled study can replicate

these pilot data, this would suggest that brief, workplace-based, positive emotion-focused stress management programs can be a practical and cost-effective strategy for reducing high blood pressure among employees and promoting a healthier and more productive workforce.

If its effectiveness is confirmed, the approach utilized in this study may help to establish a practical model that can be easily duplicated and expanded to make the benefits of this program available to larger populations. Further potential advantages, which could be assessed in future investigations, might include reduced medication usage, enhanced compliance, improved quality of life, and reduced health care costs. Such interventions may also potentially reduce significant losses to the organization as a result of cognitive decline, performance impairment, cardiovascular morbidity, and premature mortality, adverse outcomes which have been associated with sustained hypertension and chronic emotional stress. Thus, used alone or in association with other approaches, the IQM program could potentially reduce the risk and the cost to the employer of employee hypertension, stress, and negative emotional states.

## REFERENCES

- Ashby FG, Isen AM, Turken AU. A neuropsychological theory of positive affect and its influence on cognition. *Psychol Rev* 1999;106:529-550.
- Ayala C, Greenlund KJ, Croft JB, Neff LJ, Dai S, Zheng ZJ, Casper ML, Keenan NL, Mensah GA. State-specific trends in self-reported blood pressure screening and high blood pressure—United States, 1991–1999. *Morb Mortal Weekly Rep* 2002;51:456-460.
- Barefoot JC, Schroll M. Symptoms of depression, acute myocardial infarction, and total mortality in a community sample. *Circulation* 1996;93:1976-1980.
- Baron RA. Affect and organizational behavior: When and why feeling good (or bad) matters. In: Murnighan K, ed. *Social Psychology in Organizations: Advances in Theory*. New York: Prentice Hall, 1993:63-88.
- Barrios-Choplin B, Atkinson M. *Personal and Organizational Quality Assessment*. Boulder Creek, CA: HeartMath Research Center, Institute of HeartMath, 2000.
- Barrios-Choplin B, McCraty R, Cryer B. An inner quality approach to reducing stress and improving physical and emotional wellbeing at work. *Stress Med* 1997;13:193-201.
- Barrios-Choplin B, McCraty R, Sundram J, Atkinson M. *The Effect of Employee Self-Management Training on Personal and Organizational Quality*. Boulder Creek, CA: HeartMath Research Center, Institute of HeartMath, Publication No. 99-083, 1999.

- Berndt ER, Finkelstein SN, Greenberg PE, Howland RH, Keith A, Rush AJ, Russell J, Keller MB. Workplace performance effects from chronic depression and its treatment. *J Health Econ* 1998;17:511-535.
- Blakeslee TR. The Attitude Factor: Extend Your Life by Changing the Way You Think. London: Thorsons/HarperCollins, 1997.
- Burton WN, Conti DJ, Chen CY, Schultz AB, Edington DW. The role of health risk factors and disease on worker productivity. *J Occup Environ Med* 1999;41:863-877.
- Carnevale PJD, Isen AM. The influence of positive affect and visual access on the discovery of integrative solutions in bilateral negotiations. *Organizational Behav Hum Decis Proc* 1986;37:1-13.
- Charlesworth EA, Williams BJ, Baer PE. Stress management at the worksite for hypertension: Compliance, cost-benefit, health care and hypertension-related variables. *Psychosomat Med* 1984;46:387-397.
- Chesney MA, Agras WS, Benson H, Blumenthal JA, Engel BT, Foreyt JP, Kaufmann PG, Levenson RM, Pickering TG, Randall WC, Schwartz PJ. Nonpharmacologic approaches to the treatment of hypertension. *Circulation* 1987;76(1 Pt 2):I104-I109.
- Childre D. Freeze-Frame: A Scientifically Proven Technique for Clear Decision Making and Improved Health. Boulder Creek, CA: Planetary Publications, 1998.
- Childre D, Cryer B. From Chaos to Coherence: The Power to Change Performance. Boulder Creek, CA: Planetary, 2000.
- Childre D, Martin H. The HeartMath Solution. San Francisco: HarperSanFrancisco, 1999.
- Childre D, Rozman D. Overcoming Emotional Chaos: Eliminate Anxiety, Lift Depression and Create Security in Your Life. San Diego: Jodere Group, 2002.
- Collins R, Peto R, MacMahon S, Hebert P, Fiebach NH, Eberlein KA, Godwin J, Qizilbash N, Taylor JO, Hennekens CH. Blood pressure, stroke, and coronary heart disease. Part 2, Short-term reductions in blood pressure: Overview of randomised drug trials in their epidemiological context. *Lancet* 1990;335:827-838.
- Cooperrider DL, Whitney D. A positive revolution in change: Appreciative inquiry. In: Golembiewski RT, ed. *Handbook of Organizational Behavior*, 2nd ed. New York: Marcel Dekker, 2000:611-629.
- Cutler JA, Follmann D, Elliott P, Suh I. An overview of randomized trials of sodium reduction and blood pressure. *Hypertension* 1991;17(Suppl1):I27-I33.
- Danner DD, Snowdon DA, Friesen WV. Positive emotions in early life and longevity: Findings from the nun study. *J Pers Soc Psychol* 2001;80:804-813.
- Derogatis L. Brief Symptom Inventory. Minneapolis: National Computer Systems, 1993.
- Everson SA, Roberts RE, Goldberg DE, Kaplan GA. Depressive symptoms and increased risk of stroke mortality over a 29-year period. *Arch Intern Med* 1998;158:1133-1138.
- Frasere-Smith N, Lesperance F, Talajic M. Depression and 18-month prognosis after myocardial infarction. *Circulation* 1995;91:999-1005.
- Fredrickson BL. Cultivating positive emotions to optimize health and well-being. Prevention and Treatment. Online document at: [journals.apa.org/prevention/volume3/pre0030001a.html](http://journals.apa.org/prevention/volume3/pre0030001a.html) 2000a:3.
- Fredrickson BL. Why positive emotions matter in organizations: Lessons from the broaden-and-build model. *Psychologist-Manager's J* 2000b;4:131-142.
- George JM. State or trait: Effects of positive mood on prosocial behavior at work. *J Appl Psychol* 1991;76:299-307.
- George JM. Salesperson mood at work: Implications for helping customers. *J Person Selling Sales Manage* 1998;18:23-30.
- George JM, Brief AP. Feeling good—doing good: A conceptual analysis of the mood at work—organizational spontaneity relationship. *Psychol Bull* 1992;112:310-329.
- Goetzel RZ, Anderson DR, Whitmer RW, Ozminkowski RJ, Dunn RL, Wasserman J. The relationship between modifiable health risks and health care expenditures. An analysis of the multi-employer HERO health risk and cost database. The Health Enhancement Research Organization (HERO) Research Committee. *J Occup Environ Med* 1998;40:843-854.
- Guzzetti S, Piccaluga E, Casati R, Cerutti S, Lombardi F, Pagani M, Malliani A. Sympathetic predominance in essential hypertension: A study employing spectral analysis of heart rate variability. *J Hypertens* 1988;6:711-717.
- Henry JP, Stephens PM, Ely DL. Psychosocial hypertension and the defence and defeat reactions. *J Hypertens* 1986;4:687-697.
- Hypertension Detection and Follow-up Program Cooperative Group. Five-year findings of the hypertension detection and follow-up program. I. Reduction in mortality of persons with high blood pressure, including mild hypertension. *JAMA* 1979;242:2562-2571.
- Isen AM. On the relationship between affect and creative problem solving. In: Russ SW, ed. *Affect, Creative Experience, and Psychological Adjustment*. Philadelphia: Brunner/Mazel, 1998:3-17.
- Isen AM. Positive affect. In: Dalgleish T, Power M, eds. *Handbook of Cognition and Emotion*. New York: John Wiley & Sons, 1999:522-539.
- Isen AM. Positive affect and decision making. In: Lewis M, Haviland-Jones J, eds. *Handbook of Emotions*, 2nd ed., New York: Guilford Press, 2000:417-435.
- Isen AM, Daubman KA, Nowicki GP. Positive affect facilitates creative problem solving. *J Pers Soc Psychol* 1987;52:1122-1131.
- Iverson RD, Olekalns M, Erwin PJ. Affectivity, organizational stressors, and absenteeism: A causal model of burnout and its consequences. *J Vocational Behav* 1998;52:1-23.
- Jacob RG, Chesney MA, Williams DM, Ding Y, Shapiro AP. Relaxation therapy for hypertension: Design effects and treatment effects. *Ann Behav Med* 1991;13:5-17.
- Johnston DW. Stress management in the treatment of mild primary hypertension. *Hypertension* 1991;17(4 Suppl III):III63-III68.

- Julius S, Schork N, Schork A. Sympathetic hyperactivity in early stages of hypertension: The Ann Arbor data set. *J Cardiovasc Pharmacol* 1988;12(Suppl 3):S121-S129.
- Langewitz W, Ruddel H, Schachinger H. Reduced parasympathetic cardiac control in patients with hypertension at rest and under mental stress. *Am Heart J* 1994;127:122-128.
- Launer LJ, Masaki K, Petrovitch H, Foley D, Havlik RJ. The association between midlife blood pressure levels and late-life cognitive function. The Honolulu-Asia Aging Study. *JAMA* 1995;274:1846-1851.
- Lehrer P, Smetankin A, Potapova T. Respiratory sinus arrhythmia biofeedback therapy for asthma: A report of 20 unmedicated pediatric cases using the Smetankin method. *Appl Psychophysiol Biofeedback* 2000;25:193-200.
- Linden W. Psychological Perspectives of Essential Hypertension. Basel, Switzerland: S Karger AG, 1984.
- Linden W, Chambers LA. Clinical effectiveness of non-drug therapies for hypertension: A meta-analysis. *Ann Behav Med* 1994;16:35-45.
- Linden W, Lenz JW, Con AH. Individualized stress management for primary hypertension: A randomized trial. *Arch Intern Med* 2001;161:1071-1080.
- Luskin F, Reitz M, Newell K, Quinn TG, Haskell W. A controlled pilot study of stress management training of elderly patients with congestive heart failure. *Prev Cardiol* 2002;5:168-172, 176.
- MacMahon S, Cutler J, Brittain E, Higgins M. Obesity and hypertension: Epidemiological and clinical issues. *Eur Heart J* 1987;8(Suppl B):57-70.
- MacMahon S, Peto R, Cutler J, Collins R, Sorlie P, Neaton J, Abbott R, Godwin J, Dyer A, Stamler J. Blood pressure, stroke, and coronary heart disease. Part 1, Prolonged differences in blood pressure: Prospective observational studies corrected for the regression dilution bias. *Lancet* 1990;335:765-774.
- Maister DH. Practice What You Preach: What Managers Must Do to Create a High Achievement Culture. New York: Free Press, 2001.
- Markovitz JH, Matthews KA, Kannel WB, Cobb JL, D'Agostino RB. Psychological predictors of hypertension in the Framingham Study. Is there tension in hypertension? *JAMA* 1993;270:2439-2443.
- Mathias CJ. Management of hypertension by reduction in sympathetic activity. *Hypertension* 1991;17(4 Suppl III):III69-III74.
- McCaffrey RJ, Blanchard EB. Stress management approaches to the treatment of essential hypertension. *Ann Behav Med* 1985;44:203-213.
- McCraty R. Heart rhythm coherence—An emerging area of biofeedback. *Biofeedback* 2002a;30:23-25.
- McCraty R. Influence of cardiac afferent input on heart-brain synchronization and cognitive performance [abstract]. *Int J Psychophysiol* 2002b;45:72-73.
- McCraty R, Atkinson M. Psychophysiological coherence. In: Childre D, McCraty R, Wilson BC, eds. *Emotional Sovereignty*. Amsterdam: Harwood Academic Publishers, 2004:in press.
- McCraty R, Atkinson M, Lipsenthal L. Emotional Self-Regulation Program Enhances Psychological Health and Quality of Life in Patients with Diabetes. Boulder Creek, CA: HeartMath Research Center, Institute of HeartMath, Publication No. 00-006, 2000.
- McCraty R, Atkinson M, Rein G, Watkins AD. Music enhances the effect of positive emotional states on salivary IgA. *Stress Med* 1996;12:167-175.
- McCraty R, Atkinson M, Tiller WA, Rein G, Watkins AD. The effects of emotions on short term heart rate variability using power spectrum analysis. *Am J Cardiol* 1995;76:1089-1093.
- McCraty R, Atkinson M, Tomasino D. Science of the Heart. Boulder Creek, CA: HeartMath Research Center, Institute of HeartMath, Publication No. 01-001, 2001.
- McCraty R, Barrios-Choplin B, Rozman D, Atkinson M, Watkins AD. The impact of a new emotional self-management program on stress, emotions, heart rate variability, DHEA and cortisol. *Integr Physiol Behav Sci* 1998;33:151-170.
- McCraty R, Childre D. The grateful heart: The psychophysiology of appreciation. In: Emmons RA, McCullough ME, eds. *The Psychology of Gratitude*. New York: Oxford University Press, 2003:in press.
- McCraty R, Childre D. The Appreciative Heart: The Psychophysiology of Positive Emotions and Optimal Functioning. Boulder Creek, CA: HeartMath Research Center, Institute of HeartMath, Publication No. 02-026, 2002.
- McCraty R, Tomasino D, Atkinson M. Research, clinical perspectives and case histories. In: Childre D, McCraty R, Wilson BC, eds. *Emotional Sovereignty*. Amsterdam: Harwood Academic Publishers, 2004:in press.
- National Heart, Lung, and Blood Institute. The Sixth Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure. Bethesda, MD: National Institutes of Health, National Heart, Lung, and Blood Institute, National High Blood Pressure Education Program, NIH Publication No. 98-4080, 1997.
- Rein G, Atkinson M, McCraty R. The physiological and psychological effects of compassion and anger. *J Advancement Med* 1995;8:87-105.
- Rozman D, Whitaker R, Beckman T, Jones D. A pilot intervention program which reduces psychological symptomatology in individuals with human immunodeficiency virus. *Complement Ther Med* 1996;4:226-232.
- Rumantir MS, Jennings GL, Lambert GW, Kaye DM, Seals DR, Esler MD. The 'adrenaline hypothesis' of hypertension revisited: Evidence for adrenaline release from the heart of patients with essential hypertension. *J Hypertens* 2000;18:717-723.
- Salovey P, Rothman AJ, Detweiler JB, Steward WT. Emotional states and physical health. *Am Psychol* 2000;55:110-121.
- Schalekamp MA, Vincent HH, Man in't Veld AJ. Adrenaline, stress, and hypertension. *Lancet* 1983;1:362.
- Schneider RH, Staggers F, Alexander CN, Sheppard W, Rainforth M, Kondwani K, Smith S, King CG. A randomized controlled trial of stress reduction for hyper-



- tension in older African Americans. *Hypertension* 1995; 26:820-827.
- Seligman MEP, Csikszentmihalyi M. Positive psychology: An introduction. *Am Psychol* 2000;55:5-14.
- Shapiro AP. Hypertension and Stress: A Unified Concept. Mahwah, NJ: Lawrence Erlbaum Associates, 1996.
- Staw BM, Barsade SG. Affect and managerial performance: A test of the sadder-but-wiser vs. happier-and-smarter hypothesis. *Admin Sci Q* 1993;38:304-331.
- Staw BM, Sutton RL, Pelled LH. Employee positive emotion and favorable outcomes at the workplace. *Organiz Sci* 1994;5:51-70.
- Stephoe A. Stress mechanisms in hypertension. *Postgrad Med J* 1986;62:697-699.
- Swan GE, DeCarli C, Miller BL, Reed T, Wolf PA, Jack LM, Carmelli D. Association of midlife blood pressure to late-life cognitive decline and brain morphology. *Neurology* 1998;51:986-993.
- Thijs L, Fagard R, Lijnen P, Staessen J, Van Hoof R, Amery A. A meta-analysis of outcome trials in elderly hypertensives. *J Hypertens* 1992;10:1103-1109.
- Tiller WA, McCraty R, Atkinson M. Cardiac coherence: A new, noninvasive measure of autonomic nervous system order. *Altern Ther Health Med* 1996;2:52-65.
- Vaschillo E, Lehrer P, Rishe N, Konstantinov M. Heart rate variability biofeedback as a method for assessing baroreflex function: A preliminary study of resonance in the cardiovascular system. *Appl Psychophysiol Biofeedback* 2002;27:1-27.
- Ward MM, Swan GE, Chesney MA. Arousal reduction treatments for mild hypertension: A meta-analysis of recent studies. In: Julius S, Bassett DR, eds. *Behavioral Factors in Hypertension*. Amsterdam: Elsevier North Holland Publishers, 1987:285-302.
- Weiss SM. Stress management in the treatment of hypertension. *Am Heart J* 1988;116(2 Pt 2):645-649.
- Woodward JM, Chen IC. Effect of "mood that day" on pharmacists' job and career satisfaction. *Psychol Rep* 1994;74:393-394.
- World Hypertension League. Physical exercise in the management of hypertension: A consensus statement by the World Hypertension League. *J Hypertens* 1991; 9:283-287.
- Wright TA, Staw BM. Affect and favorable work outcomes: Two longitudinal tests of the happy-productive worker thesis. *J Organizational Behav* 1999;20:1-23.

Address reprint requests to:  
 Rollin McCraty, Ph.D.  
 HeartMath Research Center  
 Institute of HeartMath  
 14700 West Park Avenue  
 Boulder Creek, CA 95006

E-mail: rollin@heartmath.org